22086115

International Baccalaureate®
Baccalauréat International
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**CHEMISTRY**
**HIGHER LEVEL**
**PAPER 3**

Friday 9 May 2008 (morning)

1 hour 15 minutes

Candidate session number

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INSTRUCTIONS TO CANDIDATES

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions from two of the Options in the spaces provided. You may continue your answers on answer sheets. Write your session number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.
- At the end of the examination, indicate the letters of the Options answered in the candidate box on your cover sheet and indicate the number of answer sheets used in the appropriate box on your cover sheet.



0124

**Option B – Medicines and drugs**

**B1.** The structures of morphine, codeine and heroin are shown in Table 21 of the Data Booklet.

(a) State the type of chemical reaction used to convert morphine into the semi-synthetic opiate heroin. *[1]*

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(b) State the structural difference between the morphine and codeine molecules. *[1]*

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(c) State the main advantage and main disadvantage of using morphine as an analgesic. *[2]*

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(d) Outline **two** different types of social problem associated with the misuse of heroin. *[2]*

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**B2.** (a) (i) Name the type of drug that increases mental alertness. *[1]*

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(ii) Explain the term *sympathomimetic drug*. *[1]*

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(b) Name the sympathomimetic drug in smoking tobacco. Outline the short-term and long-term effects of its use. *[3]*

name . . . . . .

short-term effects . . . . . .

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long-term effects . . . . . .

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(c) Identify **two** structural differences between amphetamine and the hormone it is chemically related to. *[2]*

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(d) (i) State the effect of caffeine on the urinary system. *[1]*

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(ii) Identify the functional group present in both caffeine and nicotine. *[1]*

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**B3.** (a) The structures of several drugs are shown in Table 21 of the Data Booklet. Identify the drug that exists as a metal complex and name the disease it is used to treat. Draw the structure of the isomer that is **not** an effective drug. *[3]*

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(b) Thalidomide was effective in treating the symptoms of morning sickness in pregnancy. However, the drug also caused fetal deformities. Explain, with reference to the structure of the drug, why it caused these very different effects. *[4]*

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(c) Explain what is meant by *combinatorial chemistry*. *[3]*

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**Option C – Human biochemistry**

**C1.** (a) Name the type of compound formed when carboxylic acids and glycerol (propane-1,2,3-triol) combine to form fats. *[1]*

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(b) Stearic acid and linoleic acid are fatty acids that both have 18 carbon atoms in their molecular structure.

(i) The melting point of stearic acid ($M_r = 284$) is higher than that of linoleic acid ($M_r = 280$). Suggest the difference in the structures of the molecules that accounts for the difference in their melting points. *[1]*

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(ii) Explain how this difference results in linoleic acid having a lower melting point than stearic acid. *[2]*

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(c) Determine the mass of iodine, $I_2$, that reacts with one mole of linoleic acid. *[2]*

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**C2.** The structure of retinol (vitamin A) is given in Table 22 of the Data Booklet.

(a) Identify **two** functional groups present in retinol. *[2]*

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(b) State and explain whether retinol is fat-soluble or water-soluble. *[2]*

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(c) (i) Name the light-sensitive substance in the rods of the eye formed from retinol and explain its function. *[3]*

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(ii) Name **two** diseases associated with retinol deficiency. *[2]*

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**C3.** (a) Explain the action of competitive inhibitors on enzyme-catalysed reactions and state how their action is affected by an increase in substrate concentration. *[5]*

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(b) Explain how the presence of mercury compounds in a person's diet might affect cell enzyme activity. *[3]*

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(c) Identify the type of enzyme used in biological detergents and outline how it works. *[2]*

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**Option D – Environmental chemistry**

**D1.** (a) Both $CO_2$ and $N_2O$ are considered greenhouse gases. State **one** major natural and **one** major man-made source for each gas. *[4]*

$CO_2$

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$N_2O$

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(b) State **one** reason, different in each case, why both $CO_2$ and $N_2O$ are considered to be major contributors to the greenhouse effect. *[2]*

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(c) Increasing amounts of greenhouse gases in the atmosphere contribute to global warming. Discuss the effects of global warming on the environment. *[3]*

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**D2.** Acid rain may be defined as rain with a pH of less than 5.6.

(a) Identify an acid which originates from the burning of coal. *[1]*

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(b) Write the equations which show how this acid is formed. *[2]*

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(c) Suggest how the production of the acid formed as a result of burning coal can be reduced. *[2]*

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**D3.** (a) List **three** main toxic types of chemical pollutants in water. *[2]*

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(b) Nitrates in drinking water continue to raise concerns. Describe **two** sources of nitrates in drinking water and **two** possible health effects. *[4]*

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**D4.** Discuss how thermal inversions form and their effect on human health. *[5]*

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**Option E – Chemical industries**

**E1.** (a) Limestone and coke are added to the blast furnace in the production of iron. For each of these raw materials, state its function and write an equation to illustrate this function. *[4]*

Limestone

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Coke

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(b) Explain how iron produced in the blast furnace is converted to steel. *[4]*

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**E2.** (a) Describe how the manufacturing process used to produce polyurethane is modified to produce polyurethane foam. State **two** physical properties that result from this manufacturing process. *[2]*

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(b) Discuss **two** disadvantages of the use of polyurethane. *[2]*

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**E3.** Pure silicon is required for many electrical devices. Describe the extraction and purification of silicon from silica, $SiO_2$. *[4]*

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**E4.** Discuss the free-radical mechanism involved in thermal cracking and the ionic mechanism in catalytic cracking. In your answer refer to conditions and provide equations. *[9]*

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**Option F – Fuels and energy**

**F1.** List **two** desirable characteristics of an energy source. *[2]*

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**F2.** (a) Write the equations occurring at each electrode and the overall reaction for the hydrogen – oxygen alkaline fuel cell. *[3]*

negative electrode (anode) . . . . . .

positive electrode (cathode) . . . . . .

overall reaction . . . . . .

(b) The lead-acid storage battery is used in cars.

(i) Write the equations occurring at each electrode when the battery is discharging. *[2]*

negative electrode (anode) . . . . . .

positive electrode (cathode) . . . . . .

(ii) Explain why some lead-acid batteries need water added to them after some time. *[1]*

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**F3.** (a) Discuss how parabolic mirrors are used to convert solar energy into electrical energy. *[3]*

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(b) State **two** disadvantages of the use of parabolic mirrors rather than photovoltaic cells for the production of electrical energy from solar energy. *[2]*

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(c) The process of photosynthesis is a natural way of converting solar energy into other forms of energy. Write the equation for the process of photosynthesis and list **two** uses of the organic product of photosynthesis. *[2]*

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**F4.** (a) Too few or too many neutrons can cause a nucleus to be radioactive. Predict a possible mode of decay for the isotopes $^{67}_{29}Cu$ and $^{147}_{62}Sm$ and write the nuclear equations illustrating this mode of decay. *[4]*

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(b) The half-life of the most common isotope of uranium, $^{238}U$, is $4.47 \times 10^9$ years. Calculate the time taken for the activity of a sample to decay to 15 % of its original value. *[2]*

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**F5.** Nuclear waste can be classified as either high level or low level waste. Describe the characteristics of each type of waste and state **one** source of each type of waste. *[4]*

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**Option G – Modern analytical chemistry**

**G1.** (a) Identify an analytical technique that is suitable for each of the following.

(i) Determining the concentration of copper ions in a sample of water. *[1]*

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(ii) Measuring the degree of unsaturation of an oil. *[1]*

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(iii) Detecting drugs in the urine of an athlete. *[1]*

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(b) Outline how $^{1}$H NMR is used in body scanners to produce an image of a human body. *[2]*

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(c) Distinguish between emission and absorption spectra by outlining how each is produced. *[4]*

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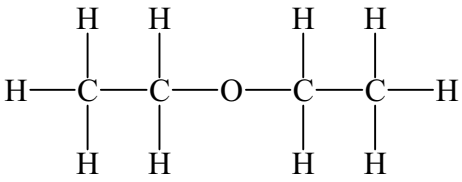
**G2.** A student was asked to predict the $^1$H NMR spectrum of ethoxyethane, whose structure is shown below.



(a) Deduce the number of different environments for hydrogen atoms in ethoxyethane. *[1]*

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(b) Using Table 19 of the Data Booklet and the structure given for ethoxyethane, predict for each environment:

(i) the chemical shift in ppm; *[2]*

$CH_3$ . . . . . .

$CH_2$ . . . . . .

(ii) the ratio of the areas under each peak; *[1]*

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(iii) the splitting pattern. *[2]*

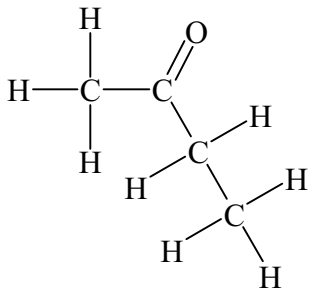
$CH_3$ . . . . . .

$CH_2$ . . . . . .

*(This question continues on the following page)*

*(Question G2 continued)*

(c) The structure of butanone is shown below. State **one** feature of the $^1$H NMR spectrum of butanone that differs from the $^1$H NMR spectrum of ethoxyethane. *[1]*



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(d) All $^1$H NMR spectra have a peak at 0 ppm. Identify the substance that produces this peak and state its function. *[2]*

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(e) Identify and account for **two** differences in the infrared spectra of ethoxyethane and butanone. *[2]*

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**G3.** (a) Using the water molecule as an example and including diagrams, describe what occurs at a molecular level during the absorption of infrared radiation. *[4]*

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(b) State the mathematical relationship between wavenumber and wavelength. *[1]*

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**Option H – Further organic chemistry**

**H1.** A common test which allows for the identification of ketones and aldehydes involves the use of 2, 4-dinitrophenylhydrazine.

(a) Using $X-NH-NH_2$ to represent 2,4-dinitrophenylhydrazine, write an equation for its reaction with propanone. *[2]*

(b) Name the type of reaction that has occurred in part (a). *[1]*

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(c) Explain how the product of the reaction in part (a) allows propanone to be distinguished from propanal. *[1]*

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**H2.** Butan-1-ol can undergo an elimination reaction to form an alkene.

(a) State the conditions used for this reaction. *[1]*

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(b) Give the mechanism for the dehydration of butan-1-ol, using curly arrows to represent the movement of electron pairs. *[5]*

(c) Explain why a tertiary alcohol undergoes dehydration more readily than a primary alcohol. *[2]*

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**H3.** (a) The following three compounds are heated separately with aqueous sodium hydroxide.

A. 1-chlorobutane
B. 2-chloromethylpropane
C. chlorobenzene

List these compounds in decreasing order of ease of hydrolysis (the compound most easily hydrolysed first). Explain your choice. *[3]*

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(b) Aqueous ammonia was used instead of aqueous sodium hydroxide as a reactant with 2-chloromethylpropane. State and explain how the rate of this reaction compares with the corresponding reaction in part (a). *[2]*

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(c) Explain why 2-chloromethylpropane does not undergo an $S_N2$ mechanism. *[1]*

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**H4.** One reason why the use of chloroalkanes is decreasing is because of their effect on the ozone layer. Describe, using equations, how gas phase reactions involving chloroalkanes affect the concentration of ozone in the atmosphere. *[4]*

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**H5.** Using Table 16 of the Data Booklet, explain the difference in p$K_a$ values for the following compounds. *[3]*

A. Chloroethanoic acid and ethanoic acid
B. Chloroethanoic acid and trichloroethanoic acid
C. Chloroethanoic acid and iodoethanoic acid

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